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Singh et al.

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(54) **ELECTRONIC DEVICE AND METHOD OF DETECTING TOUCHES ON A TOUCH-SENSITIVE DISPLAY**

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G06F 3/041 (2006.01)

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CPC ***G06F 1/3262*** (2013.01); ***G06F 3/0416*** (2013.01)

(58) **Field of Classification Search**
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USPC 345/156–174; 178/18.06
See application file for complete search history.

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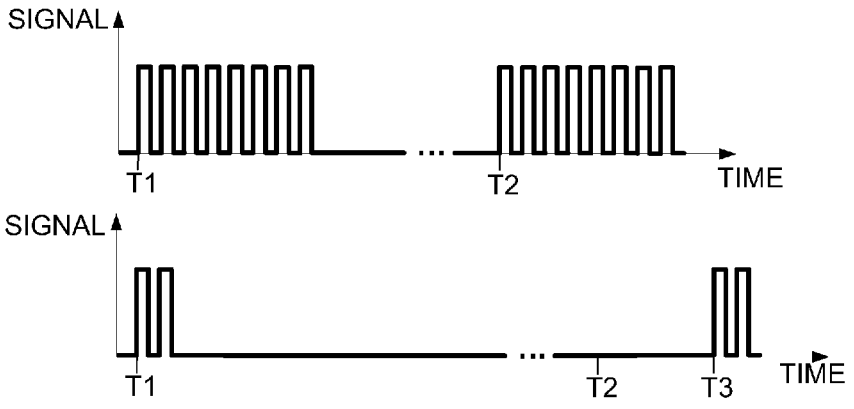
(57) **ABSTRACT**

A method includes applying a first plurality of pulses to scanning electrodes during a first scan to detect touches on a touch-sensitive display, receiving an indication to scan in a reduced power condition, and when in the reduced power condition, applying a second plurality of pulses to scanning electrodes during a second scan to detect touches on the touch-sensitive display, wherein the second plurality of pulses comprises fewer pulses than the first plurality of pulses.

14 Claims, 4 Drawing Sheets



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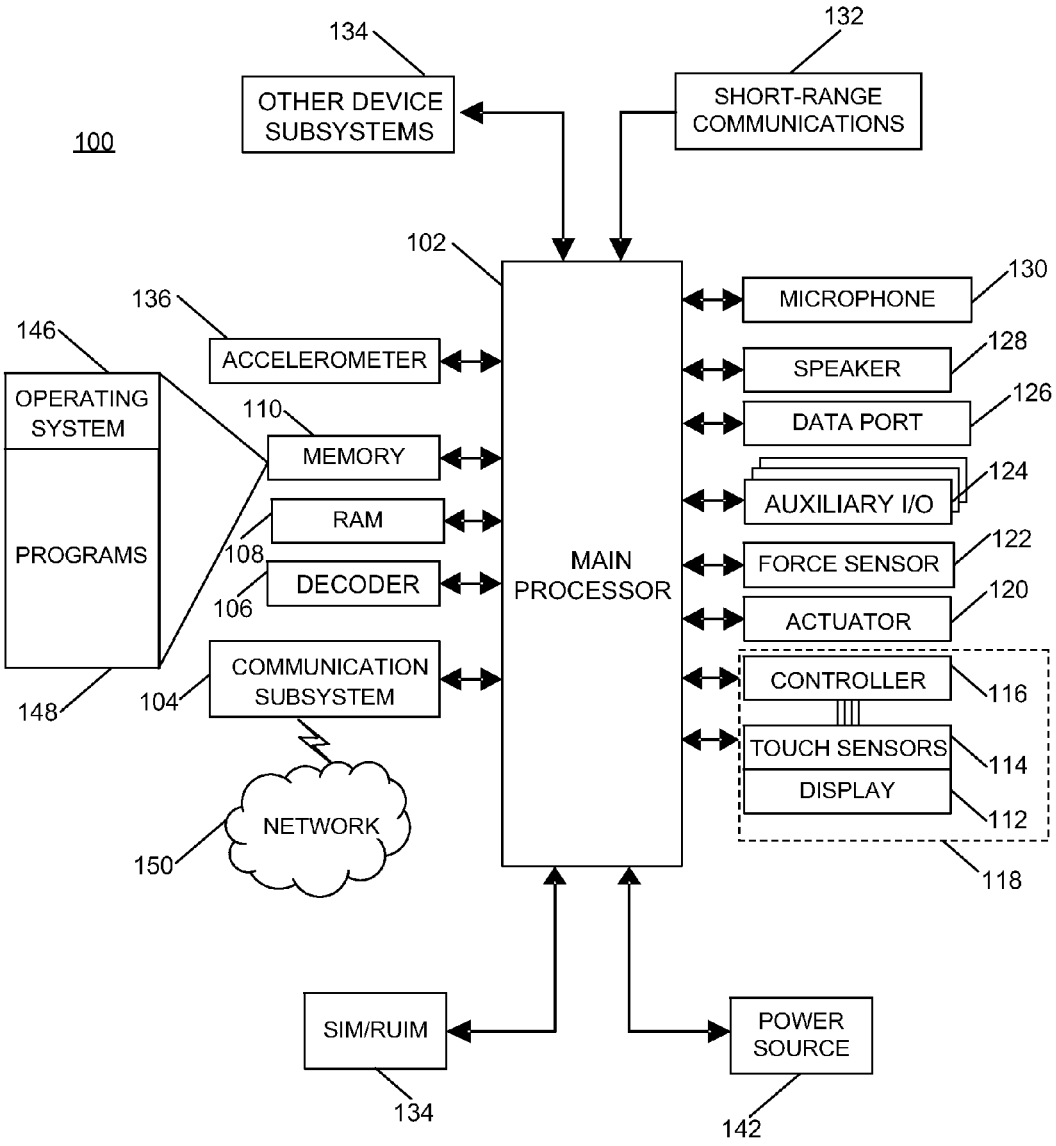
100
134
OTHER DEVICE SUBSYSTEMS
132
SHORT-RANGE COMMUNICATIONS
102
MAIN PROCESSOR
136
ACCELEROMETER
146
OPERATING SYSTEM
PROGRAMS
110
MEMORY
RAM
108
DECODER
106
COMMUNICATION SUBSYSTEM
104
148
NETWORK
150
MICROPHONE
130
SPEAKER
128
DATA PORT
126
AUXILIARY I/O
124
FORCE SENSOR
122
ACTUATOR
120
CONTROLLER
116
TOUCH SENSORS
114
DISPLAY
112
118
SIM/RUIM
134
POWER SOURCE
142

FIG. 1

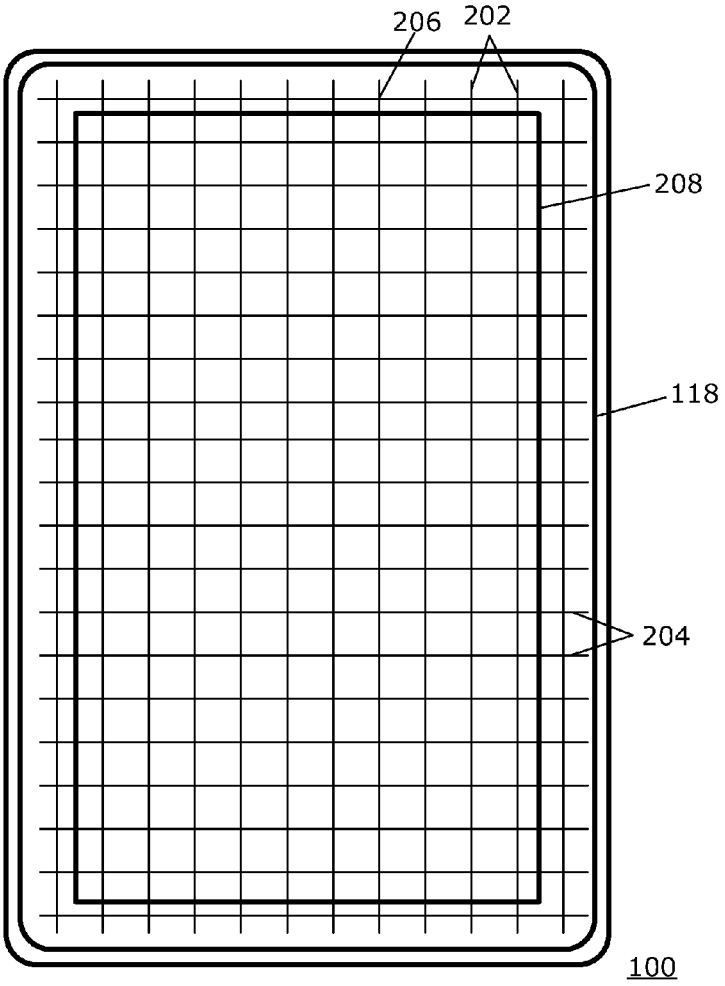

FIG. 2

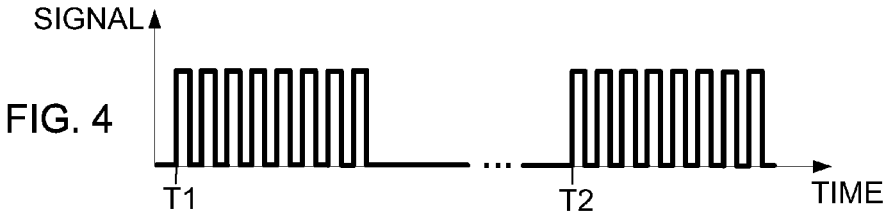

FIG. 4

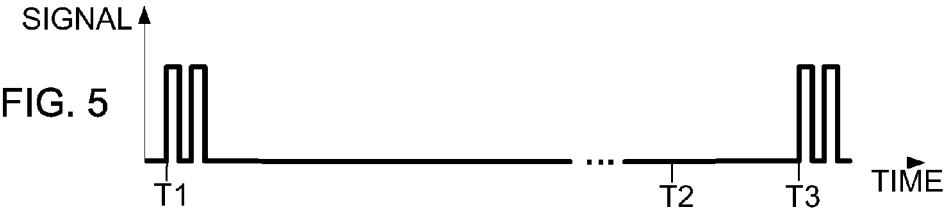

FIG. 5

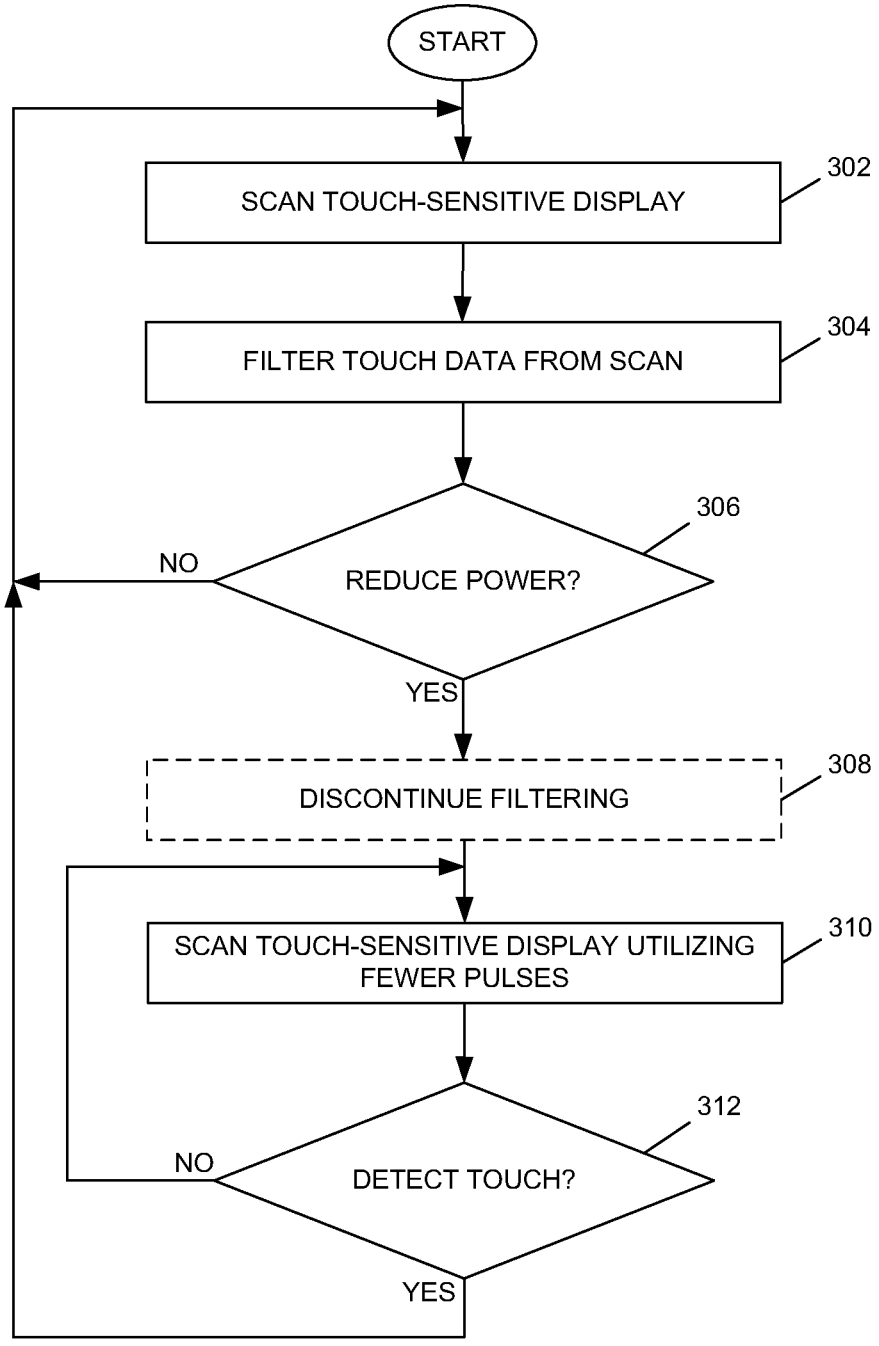
START
SCAN TOUCH-SENSITIVE DISPLAY
302
FILTER TOUCH DATA FROM SCAN
304
REDUCE POWER?
306
NO
YES
DISCONTINUE FILTERING
308
SCAN TOUCH-SENSITIVE DISPLAY UTILIZING FEWER PULSES
310
DETECT TOUCH?
312
NO
YES

FIG. 3

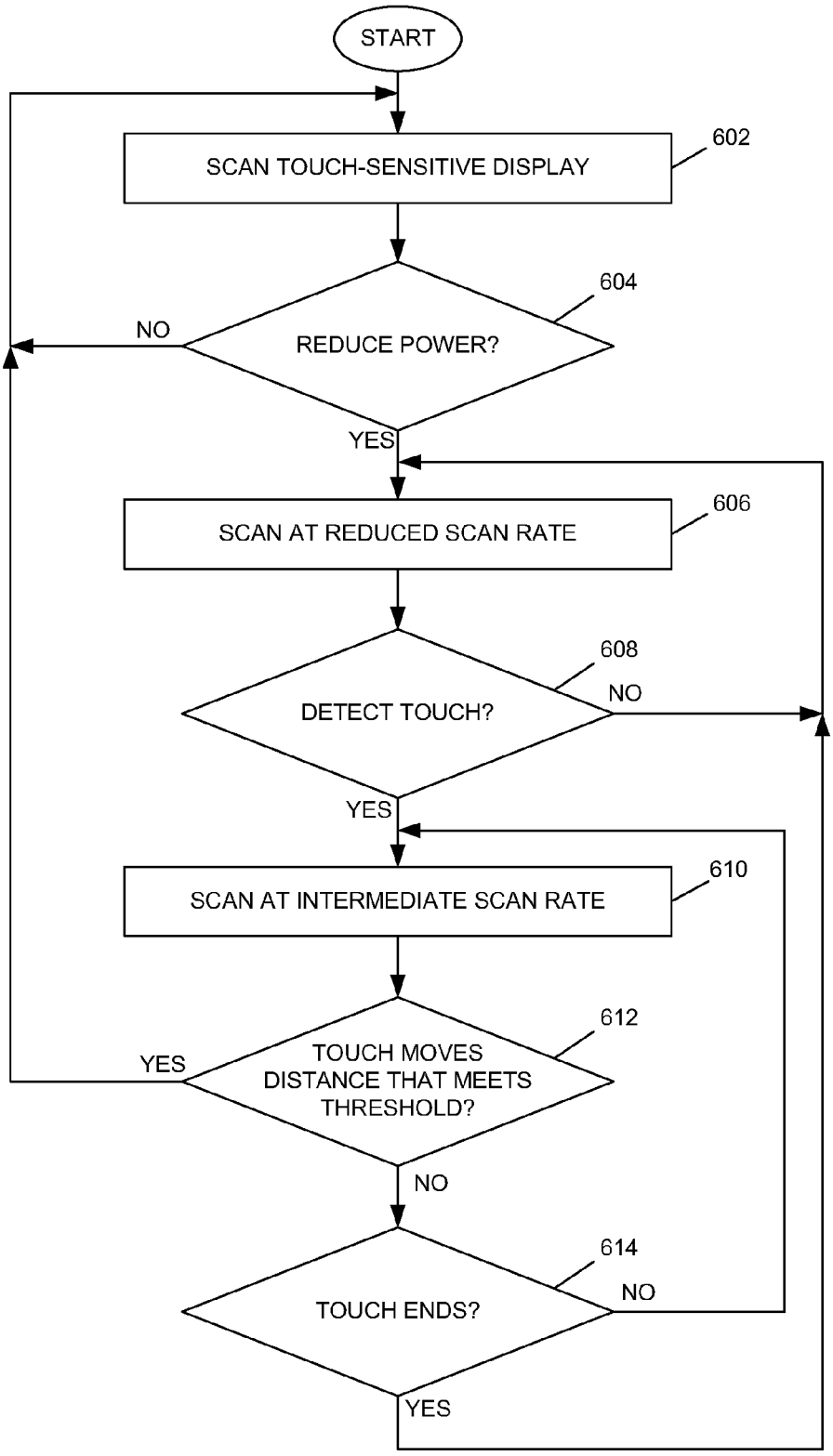
START
SCAN TOUCH-SENSITIVE DISPLAY
602
REDUCE POWER?
604
NO
YES
SCAN AT REDUCED SCAN RATE
606
DETECT TOUCH?
608
NO
YES
SCAN AT INTERMEDIATE SCAN RATE
610
TOUCH MOVES DISTANCE THAT MEETS THRESHOLD?
612
YES
NO
TOUCH ENDS?
614
NO
YES

FIG. 6

ELECTRONIC DEVICE AND METHOD OF DETECTING TOUCHES ON A TOUCH-SENSITIVE DISPLAY

FIELD OF TECHNOLOGY

The present disclosure relates to electronic devices including, but not limited to, portable electronic devices having touch-sensitive displays and their control.

BACKGROUND

Electronic devices, including portable electronic devices, have gained widespread use and may provide a variety of functions including, for example, telephonic, electronic messaging and other personal information manager (PIM) application functions. Portable electronic devices include several types of devices including mobile stations such as simple cellular telephones, smart telephones (smart phones), Personal Digital Assistants (PDAs), tablet computers, and laptop computers, with wireless network communications or near-field communications connectivity such as Bluetooth® capabilities.

Portable electronic devices such as PDAs, or tablet computers are generally intended for handheld use and ease of portability. Smaller devices are generally desirable for portability. A touch-sensitive display, also known as a touch-screen display, is particularly useful on handheld devices, which are small and may have limited space for user input and output. The information displayed on the display may be modified depending on the functions and operations being performed.

Improvements in electronic devices with touch-sensitive displays are desirable.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a portable electronic device in accordance with the disclosure.

FIG. **2** is a front view of an electronic device in accordance with the disclosure.

FIG. **3** is a flowchart illustrating an example of a method of detecting touches on a touch-sensitive display in accordance with the disclosure.

FIG. **4** and FIG. **5** illustrate pulses of a signal utilized to drive a drive electrode during scanning in accordance with the disclosure.

FIG. **6** is a flowchart illustrating an example of a method of detecting touches on a touch-sensitive display in accordance with the disclosure.

DETAILED DESCRIPTION

The following describes an electronic device and a method including applying a first plurality of pulses to scanning electrodes during a first scan to detect touches on a touch-sensitive display, receiving an indication to scan in a reduced power condition, and when in the reduced power condition, applying a second plurality of pulses to scanning electrodes during a second scan to detect touches on the touch-sensitive display, wherein the second plurality of pulses comprises fewer pulses than the first plurality of pulses.

For simplicity and clarity of illustration, reference numerals may be repeated among the figures to indicate corresponding or analogous elements. Numerous details are set forth to provide an understanding of the embodiments described herein. The embodiments may be practiced without these details. In other instances, well-known methods, procedures, and components have not been described in detail to avoid obscuring the embodiments described. The description is not to be considered as limited to the scope of the embodiments described herein.

The disclosure generally relates to an electronic device, such as a portable electronic device as described herein. Examples of electronic devices include mobile, or handheld, wireless communication devices such as pagers, cellular phones, cellular smart-phones, wireless organizers, personal digital assistants, wirelessly enabled notebook computers, tablet computers, mobile internet devices, electronic navigation devices, and so forth. The portable electronic device may also be a portable electronic device without wireless communication capabilities, such as a handheld electronic game device, digital photograph album, digital camera, media player, e-book reader, and so forth.

A block diagram of an example of a portable electronic device **100** is shown in FIG. **1**. The portable electronic device **100** includes multiple components, such as a processor **102** that controls the overall operation of the portable electronic device **100**. Communication functions, including data and voice communications, are performed through a communication subsystem **104**. Data received by the portable electronic device **100** is decompressed and decrypted by a decoder **106**. The communication subsystem **104** receives messages from and sends messages to a wireless network **150**. The wireless network **150** may be any type of wireless network, including, but not limited to, data wireless networks, voice wireless networks, and networks that support both voice and data communications. A power source **142**, such as one or more rechargeable batteries or a port to an external power supply, powers the portable electronic device **100**.

The processor **102** interacts with other components, such as a Random Access Memory (RAM) **108**, memory **110**, a touch-sensitive display **118**, one or more actuators **120**, one or more force sensors **122**, an auxiliary input/output (I/O) subsystem **124**, a data port **126**, a speaker **128**, a microphone **130**, short-range communications **132** and other device subsystems **134**. The touch-sensitive display **118** includes a display **112** and touch sensors **114** that are coupled to at least one controller **116** that is utilized to interact with the processor **102**. Input via a graphical user interface is provided via the touch-sensitive display **118**. Information, such as text, characters, symbols, images, icons, and other items that may be displayed or rendered on a portable electronic device, is displayed on the touch-sensitive display **118** via the processor **102**. The processor **102** may also interact with an accelerometer **136** that may be utilized to detect direction of gravitational forces or gravity-induced reaction forces.

To identify a subscriber for network access, the portable electronic device **100** may utilize a Subscriber Identity Module or a Removable User Identity Module (SIM/RUIM) card **138** for communication with a network, such as the wireless network **150**. Alternatively, user identification information may be programmed into memory **110**.

The portable electronic device **100** includes an operating system **146** and software programs, applications, or components **148** that are executed by the processor **102** and are typically stored in a persistent, updatable store such as the memory **110**. Additional applications or programs may be loaded onto the portable electronic device **100** through the wireless network **150**, the auxiliary I/O subsystem **124**, the data port **126**, the short-range communications subsystem **132**, or any other suitable subsystem **134**.

A received signal such as a text message, an e-mail message, or web page download is processed by the communica-

tion subsystem **104** and input to the processor **102**. The processor **102** processes the received signal for output to the display **112** and/or to the auxiliary I/O subsystem **124**. A subscriber may generate data items, for example e-mail messages, which may be transmitted over the wireless network **150** through the communication subsystem **104**. For voice communications, the overall operation of the portable electronic device **100** is similar. The speaker **128** outputs audible information converted from electrical signals, and the microphone **130** converts audible information into electrical signals for processing.

The touch-sensitive display **118** may be any suitable touch-sensitive display, such as a capacitive, resistive, infrared, surface acoustic wave (SAW) touch-sensitive display, strain gauge, optical imaging, dispersive signal technology, acoustic pulse recognition, and so forth. A capacitive touch-sensitive display includes one or more capacitive touch sensors **114**. The capacitive touch sensors may comprise any suitable material, such as indium tin oxide (ITO).

One or more touches, also known as touch contacts or touch events, may be detected by the touch-sensitive display **118**. The processor **102** may determine attributes of the touch, including a location of the touch. Touch location data may include data for an area of contact or data for a single point of contact, such as a point at or near a center of the area of contact. The location of a detected touch may include x and y components, e.g., horizontal and vertical components, respectively, with respect to one's view of the touch-sensitive display **118**. A touch may be detected from any suitable input member, such as a finger, thumb, appendage, or other objects, for example, a stylus, pen, or other pointer, depending on the nature of the touch-sensitive display **118**. Multiple simultaneous touches may be detected.

One or more gestures may also be detected by the touch-sensitive display **118**. A gesture, such as a swipe, also known as a flick, is a particular type of touch on a touch-sensitive display **118** and may begin at an origin point and continue to an end point, for example, a concluding end of the gesture. A gesture may be identified by attributes of the gesture, including the origin point, the end point, the distance travelled, the duration, the velocity, and the direction, for example. A gesture may be long or short in distance and/or duration. Two points of the gesture may be utilized to determine a direction of the gesture. A gesture may also include a hover. A hover may be a touch at a location that is generally unchanged over a period of time or is associated with the same selection item for a period of time.

Optional force sensors **122** may be disposed in conjunction with the touch-sensitive display **118** to determine or react to forces applied to the touch-sensitive display **118**. The force sensor **122** may be disposed in line with a piezo actuator **120**. The force sensors **122** may be force-sensitive resistors, strain gauges, piezoelectric or piezoresistive devices, pressure sensors, quantum tunneling composites, force-sensitive switches, or other suitable devices. Force as utilized throughout the specification, including the claims, refers to force measurements, estimates, and/or calculations, such as pressure, deformation, stress, strain, force density, force-area relationships, thrust, torque, and other effects that include force or related quantities. Optionally, force information related to a detected touch may be utilized to select information, such as information associated with a location of a touch. For example, a touch that does not meet a force threshold may highlight a selection option, whereas a touch that meets a force threshold may select or input that selection option. Selection options include, for example, displayed or virtual keys of a keyboard; selection boxes or windows, e.g., "cancel," "delete," or "unlock"; function buttons, such as play or stop on a music player; and so forth. Different magnitudes of force may be associated with different functions or input. For example, a lesser force may result in panning, and a higher force may result in zooming.

A front view of an example of the electronic device **100** is shown in FIG. **2**. The electronic device **100** includes the touch-sensitive display **118**. The touch-sensitive display **118** may be a capacitive touch-sensitive display that includes capacitive touch sensors. The touch sensors include, for example, drive electrodes, also referred to as scanning electrodes, and sense electrodes. The electrodes **202** and the electrodes **204** may comprise any suitable material, such as indium tin oxide (ITO). The electrodes **202** and the electrodes **204** are not visible when viewing the electronic device **100** but are illustrated in FIG. **2** for the purpose of the present description. In the example illustrated in FIG. **2**, the vertical electrodes **202** may be the drive electrodes and the horizontal electrodes **204** may be the sense electrodes. Alternatively, the horizontal electrodes **204** may be the drive electrodes and the vertical electrodes **202** may be the sense electrodes.

The touch-sensitive display **118** includes a display area in which information may be displayed, and a non-display area extending around the periphery of the display area. The display area may include the area inside the rectangle **208** in FIG. **2** and the non-display area may include a surrounding area. Information is typically not displayed in the non-display area, which area is utilized to accommodate, for example, electronic traces or electrical connections, adhesives or other sealants, and/or protective coatings around the edges of the display area. The electrodes **202** and the electrodes **206** may be disposed in the non-display area or may extend from the display area into the non-display area.

In this example, the drive electrodes **202** and the sense electrodes **204** are coupled to the touch controller **116**, for example, via a flex connector. The drive electrodes **202** are driven by the touch controller **116** such that pulses of signal are carried by the drive electrodes **202**. The signal may be, for example, current or applied voltage. The sense electrodes **204** are utilized to detect changes in the signal at the nodes **206**, which are the locations at which the sense electrodes **204** cross over the drive electrodes **202**. To determine a touch location, the touch-sensitive display **118** is scanned by driving the drive electrodes **202** while signals from sense electrodes **204** are received at the touch controller **116**. Each scan of the touch-sensitive display **118** includes multiple frames. In each frame, a drive electrode **202** is driven utilizing multiple pulses, while receiving signals from a sense electrode **204**. Each drive electrode **204** may be driven in multiple frames while sensing utilizing each of the sense electrodes **204**.

A flowchart illustrating an example of a method of detecting touches on the touch-sensitive display **118** is shown in FIG. **3**. The method may be carried out by software executed, for example, by the touch controller **116**. Coding of software for carrying out such a method is within the scope of a person of ordinary skill in the art given the present description. The method may contain additional or fewer processes than shown and/or described, and may be performed in a different order. Computer-readable code executable by at least one processor of the portable electronic device to perform the method may be stored in a computer-readable storage medium, such as a non-transitory computer-readable storage medium, which medium is tangible.

During operation of the portable electronic device **100**, the touch-sensitive display is scanned **302** by driving the drive electrodes **202** while signals from the sense electrodes **204**

are received at the touch controller **116**. During a frame of the scan, one drive electrode **202** is driven by applying multiple pulses of a signal, such as shown in FIG. **4**, while sensing utilizing a sense electrode **204**. Frames of two scans are illustrated in FIG. **4**. The frame start times are separated by a period of time from T1 to T2. Between frames for a given drive electrode **204**, other drive electrodes **204** may be driven.

Touch data is received at the controller **116** during scanning of the touch-sensitive display **118** and the touch data may be filtered **304** at the controller **116**. For example, the touch data may be compared to touch data previously reported by the controller **116** to the processor **102**. When, for example, a touch is detected, and the touch does not move by a threshold distance, the new touch location may not be reported to the processor **102**. This filtering is performed to reduce the noise and/or jitter and reduce the data reported to the processor **102**. Alternatively, other noise reduction methods may be utilized to improve accuracy of a reported touch. For example, a common mode noise reduction method may be utilized.

When an indication to enter a low-power condition, or reduced power condition, is received **306**, for example, from the processor **102**, the process continues at **308**. The indication may be a command received from the processor. The low-power condition or reduced power condition, which may be referred to as a "sleep" condition or state, is a condition in which no information is displayed on the touch-sensitive display. During a low-power condition, the electronic device **100** may discontinue processes or operate processes at a slower speed and one or more hardware components may be powered-down or operated at a slower speed to conserve power or provide other advantages. The electronic device **100** may operate in the low-power condition when the processor **102** determines that no touch is detected on the touch-sensitive display **118** for a period of time that meets a threshold, when no input is generally detected by the electronic device **100**, when the device is locked by selection of a button or receipt of a gesture on the touch-sensitive display **118**, or when the device is placed in a holster or covered by a cover, to name a few examples.

Optionally, the filtering at the controller **116** may be discontinued **308** to reduce the power utilized by the processor to perform the filtering. The touch-sensitive display is scanned **310** by applying fewer pulses to the drive electrodes than the number of pulses utilized in a normal or full-power condition. During a frame of the scan, a drive electrode **204** is driven by applying fewer pulses of current/voltage while sensing utilizing a sense electrode **204**. For example, a drive electrode **204** may be driven utilizing half the number of pulses utilized to drive the electrode **204** during scanning at **302**. Power is conserved by driving the scan electrodes utilizing fewer pulses than the number of pulses utilized in a full-power condition, such as shown in FIG. **5**. Fewer pulses are applied to each scanning electrode during a scan when the electronic device **100** is in the low-power condition than the number of pulses applied to each scanning electrode during a scan when the electronic device is in the full-power condition. A touch on the touch-sensitive display **118** is detectable when the scanning electrodes are driven utilizing fewer pulses. Fewer pulses may result in reduced touch location accuracy.

When a touch on the touch-sensitive display is detected **312**, the process continues at **302**. The drive electrodes **204** are again driven utilizing a greater number of pulses during scanning in response to detecting the touch.

Thus, the portable electronic device **100** may utilize less power by applying fewer pulses to the drive electrodes **204** to detect a touch. When a touch is detected, the location may be accurately and reliably determined by resuming scanning by applying a greater number of pulses to the drive electrodes **204**. By reducing the number of pulses applied to the drive electrodes **204**, touches on the touch-sensitive display are still detected and the chance of not detecting a touch or missing the touch is low.

An example of multiple pulses of a signal utilized to drive a drive electrode **202** in one frame of a scan is illustrated in FIG. **4**. In this example, the frame includes 8 pulses that are utilized to drive a drive electrode **202**. Eight pulses, which may be square-wave pulses, may be utilized when the electronic device is operating in a full-power condition. A drive electrode **202** may be driven with eight pulses in a frame of a scan. A different drive electrode **202** is driven in each successive frame of the scan.

Another example of multiple pulses of a signal utilized to drive a drive electrode **202** in one frame of a scan is illustrated in FIG. **5**. In this example, 2 pulses are utilized to drive the drive electrode **202** in one frame of a scan when the portable electronic device **100** is operating in the low-power condition. 2 pulses are utilized to drive an electrode in a frame of a scan, rather than 8 pulses, to conserve power while detecting a touch. Each of the drive electrodes **202** may be driven with 2 pulses in a frame of a scan. The time during which the drive electrodes **202** are driven when the portable electronic device **100** is operating in the low-power condition is much less than the time during which the drive electrodes **202** are driven when in the full-power condition. Thus, the total time of one scan when operating in the low-power condition is much less than the total time of one scan when operating in the full-power condition. The sleep time, which is the time between scans, is increased when in the low-power condition compared to the full-power condition. The number of pulses may be reduced from the number utilized when in the full-power condition to any number. The pulses may be spread apart in time such that the time between pulses may be increased when in the low-power condition compared to the time between pulses when in the full-power condition. For example, the scans in the low-power condition may be separated by a time from T1 to T3, where T3 is further out in time than T2.

A flowchart illustrating another example of a method of detecting touches on the touch-sensitive display **118** is shown in FIG. **6**. The method may be carried out by software executed, for example, by the touch controller **116**. Coding of software for carrying out such a method is within the scope of a person of ordinary skill in the art given the present description. The method may contain additional or fewer processes than shown and/or described, and may be performed in a different order. Computer-readable code executable by at least one processor of the portable electronic device to perform the method may be stored in a computer-readable medium, such as a non-transitory computer-readable medium.

The touch-sensitive display **118** is scanned **602** at regular intervals in time to detect touches and to detect movement of touches on the touch-sensitive display **118**. The touch-sensitive display **118** is scanned by driving the drive electrodes **202** while signals from sense electrodes **204** are received at the touch controller **116**. Each scan of the touch-sensitive display **118** includes multiple frames in which a drive electrode **202** is driven while receiving signals from a sense electrode **204**. Information may also be displayed on the touch-sensitive display **118**.

When an indication to enter a low-power condition is received **604**, for example, from the processor **102**, the process continues at **606**. The indication may be a command received from the processor **102** when the processor **102**

determines that no touch is detected on the touch-sensitive display **118** for a period of time that meets a threshold, when no input is generally detected by the electronic device **100**, when the device is locked by selection of a button or receipt of a gesture on the touch-sensitive display **118**, or when the device is placed in a holster or covered by a cover, to name a few examples.

The touch-sensitive display **118** is scanned **606** at a reduced scanning rate by increasing the period of time between scans of the touch-sensitive display **118**. The scans may be carried out at regular intervals in time and the time during which scans are not performed is increased. Power consumption is reduced by scanning the touch-sensitive display **118** less frequently. Display of information may also be discontinued.

The touch-sensitive display **118** is scanned less frequently until, for example, a touch is detected on the touch-sensitive display **118**. In response to detecting **608** a touch on the touch-sensitive display **118**, the process continues at **610** and the touch-sensitive display **118** is scanned **610** at an intermediate scanning rate. The intermediate scanning rate is a scanning rate that is between scanning rate when the electronic device **100** operates in the full-power condition, referred to as the full-power scanning rate, and the scanning rate when the electronic device **100** operates in the low-power condition at **606**, referred to as the low-power scanning rate. The scanning rate is increased to the intermediate scanning rate by decreasing the time between scans such that the time between scans is greater than the time between scans at **602** and less than the time between scans at **606**. For example, the time between scans may be an average of the time between scans at **602** and the time between scans at **606**.

When the touch moves a distance that meets a threshold at **612**, the process continues at **602** and the touch-sensitive display **118** is again scanned at the full-power scanning rate. Thus, the distance between the detected touch location and the original touch location for that touch is determined. When the distance meets a threshold distance, the scanning resumes at **602**. A value may meet a threshold when the value is equal to or exceeds the threshold.

When the touch does not move a distance that meets the threshold, the process continues at **614**. When the touch ends **614**, the process continues at **606** and the touch-sensitive display **118** is again scanned at the low-power scanning rate. When the touch does not end at **614**, scanning continues at the intermediate scanning rate.

The method of detecting touches described with reference to FIG. **4** may be performed separate from or with the method described with reference to FIG. **3**. For example, when the electronic device **100** enters the low-power condition at **306**, the scanning at **310** may also be performed at a reduced scanning rate by increasing the period of time between scans of the touch-sensitive display **118**. In response to detecting a touch on the touch-sensitive display **118**, the touch-sensitive display **118** may be scanned at the intermediate scanning rate. When the touch moves a distance that meets a threshold, the touch-sensitive display **118** is again scanned at the full-power scanning rate.

A method includes applying a first plurality of pulses to scanning electrodes during a first scan to detect touches on a touch-sensitive display, receiving an indication to scan in a reduced power condition, and when in the reduced power condition, applying a second plurality of pulses to scanning electrodes during a second scan to detect touches on the touch-sensitive display, wherein the second plurality of pulses comprises fewer pulses than the first plurality of pulses. An electronic device includes a touch-sensitive display comprising scanning electrodes, sense electrodes, and at least one controller coupled to the scanning electrodes and the sense electrodes, and configured to apply a first plurality of pulses to the scanning electrodes during a first scan to detect touches on the touch-sensitive display, receive an indication to scan in a reduced power condition, and, when in the reduced power condition, apply a second plurality of pulses to scanning electrodes during a second scan to detect touches on the touch-sensitive display, wherein the second plurality of pulses comprises fewer pulses than the first plurality of pulses. A method includes scanning a touch-sensitive display at a first scanning rate to detect touches on the touch-sensitive display, scanning the touch-sensitive display at a second scanning rate that is less than the first scanning rate to detect touches in a reduced power condition, and in response to detecting a touch when scanning at the second scanning rate, scanning the touch-sensitive display at a third scanning rate, wherein the third scanning rate is between the first scanning rate and the second scanning rate.

Power consumption is reduced when scanning at the low power scanning rate. Power consumption is increased when a touch is detected such that movement of the touch is detectable. Power consumption is not increased to full power until the touch moves at least a threshold distance. Thus, a gesture on the touch-sensitive display **118** may be utilized to again display information and resume scanning of the touch-sensitive display **118** at the full power scanning rate. Touches, such as inadvertent touches, that do not move the threshold distance on the touch-sensitive display **118** do not cause the touch-sensitive display **118** to return to full power scanning.

The present disclosure may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the present disclosure is, therefore, indicated by the appended claims rather than by the foregoing description. All changes that come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed is:

1. A method comprising:

scanning a touch-sensitive display in a plurality of first frames to detect touches on the touch-sensitive display in a full-power operating condition by, during each of the plurality of first frames, driving a respective one of the drive electrodes by applying a first plurality of pulses to the respective one of the drive electrodes while sensing utilizing the sense electrodes;

receiving an indication to scan in a reduced power condition; and

when in the reduced power condition, scanning the touch-sensitive display in a plurality of second frames to detect touches on the touch-sensitive display by, during each of the plurality of second frames, driving the respective one of the drive electrodes by applying a second plurality of pulses to the respective one of the drive electrodes while sensing utilizing the sense electrodes;

wherein the second plurality of pulses comprises fewer pulses than the first plurality of pulses such that fewer pulses are applied to each drive electrode when in the reduced power condition than when in the full-power operating condition, wherein the time during which the pulses are applied in one frame when in the reduced power condition is less than the time during which the pulses are applied in one frame when in the full-power operating condition and the pulses applied in one frame when in the reduced power condition are spread apart such that a time between pulses applied in one frame

when in the reduced power condition is increased compared to the time between pulses applied in one frame when in the full-power operating condition, and

wherein a sleep time between scans of the touch-sensitive display is greater when in the reduced power condition compared to the time between scans of the touch-sensitive display when in the full-power operating condition.

2. The method according to claim **1**, wherein applying the first plurality of pulses comprises applying pulses to a first drive electrode during a first scan, and wherein applying a second plurality of pulses comprises applying fewer pulses to the first drive electrode during a second scan.

3. The method according to claim **1**, comprising, in response to detecting a touch when in the reduced power condition, scanning the touch-sensitive display in a plurality of third frames to detect touches on the touch-sensitive display by, during each of the plurality of third frames, driving the respective one of the drive electrodes by applying a third plurality of pulses to the respective one of the drive electrodes while sensing utilizing the sense electrodes.

4. The method according to claim **1**, wherein receiving an indication comprises receiving, from a processor, a command to enter the reduced power condition.

5. The method according to claim **1**, comprising filtering data received from sense electrodes during scanning in the full-power operating condition by:

comparing the data to previous touch data which was previously reported by a touch controller to a processor; and

reporting the data received from the sense electrodes, by the touch controller to the processor only when a touch location associated with the data received from the sense electrodes differs from a previous touch location associated with the previous touch data by a threshold distance, and

discontinuing filtering when in the reduced power condition.

6. The method according to claim **1**, wherein scanning is performed at a first scanning rate when in the full-power operating condition, scanning is performed at a second scanning rate when in the reduced power operating condition, scanning is performed at a third scanning rate in response to detecting a touch on the touch-sensitive display when in the reduced power operating condition, and wherein the third scanning rate is between the first scanning rate and the second scanning rate.

7. An electronic device comprising:

a touch-sensitive display comprising:

drive electrodes;

sense electrodes; and

at least one controller coupled to the scanning electrodes and the sense electrodes and configured to:

perform a first scan of the touch-sensitive display in a plurality of first frames to detect touches on the touch-sensitive display in a full-power operating condition by, during each of the plurality of first frames, driving a respective one of the drive electrodes by applying a first plurality of pulses to the respective one of the drive electrodes;

receive an indication to scan in a reduced power condition;

when in the reduced power condition, perform a second scan of the touch-sensitive display in a plurality of second frames to detect touches on the touch-sensitive display by, during each of the plurality of second frames, driving the respective one of the drive electrodes by applying a second plurality of pulses to the respective one of the drive electrodes, wherein the second plurality of pulses comprises fewer pulses than the first plurality of pulses such that fewer pulses are applied to each drive electrode when in the reduced power condition than when in the full-power operating condition, wherein the time during which the pulses are applied in one frame when in the reduced power condition is less than the time during which the pulses are applied in one frame when in the full-power operating condition and the pulses applied in one frame when in the reduced power condition are spread apart such that a time between pulses applied in one frame when in the reduced power condition is increased compared to the time between pulses applied in one frame when in the full-power operating condition, and

wherein a sleep time between scans of the touch-sensitive display is greater when in the reduced power condition compared to the time between scans of the touch-sensitive display when in the full-power operating condition.

8. The electronic device according to claim **7**, wherein the first plurality of pulses comprises pulses applied to a first drive electrode during the first scan, and wherein the second plurality of pulses comprises fewer pulses applied to the first drive electrode during the second scan.

9. The electronic device according to claim **7**, wherein the controller is configured to, in response to detecting a touch when in the reduced power condition, scan the touch-sensitive display in a plurality of third frames to detect touches on the touch-sensitive display by, during each of the plurality of third frames, driving the respective one of the drive electrodes by applying a third plurality of pulses to the respective one of the drive electrodes while sensing utilizing the sense electrodes.

10. The electronic device according to claim **7**, wherein the controller is configured to:

filter data received from sense electrodes during the first scan by:

comparing the data to previous touch data which was previously reported by the controller to a processor of the electronic device; and

reporting the data received from the sense electrodes, by the touch controller to the processor, only when a touch location associated with the data received from the sense electrodes differs from a previous touch location associated with the previous touch data by a threshold distance; and

discontinue filtering when in the reduced power condition.

11. A non-transitory computer-readable storage medium having computer-readable code stored thereon, the computer-readable code executable by at least one of a controller and a processor of the portable electronic device to:

scanning a touch-sensitive display in a plurality of first frames to detect touches on the touch-sensitive display in a full-power operating condition by, during each of the plurality of first frames, driving a respective one of the drive electrodes by applying a first plurality of pulses to the respective one of the drive electrodes while sensing utilizing the sense electrodes;

receive an indication to scan in a reduced power condition; and

when in the reduced power condition, scanning the touch-sensitive display in a plurality of second frames to detect touches on the touch-sensitive display by, during each of the plurality of second frames, driving the respective one of the drive electrodes by applying a second plurality of pulses to the respective one of the drive electrodes while sensing utilizing the sense electrodes;

wherein the second plurality of pulses comprises fewer pulses than the first plurality of pulses such that fewer pulses are applied to each drive electrode when in the reduced power condition than when in the full-power operating condition, wherein the time during which the pulses are applied in one frame when in the reduced power condition is less than the time during which the pulses are applied in one frame when in the full-power operating condition, and the pulses applied in one frame when in the reduced power condition are spread apart such that a time between pulses applied in one frame when in the reduced power condition is increased compared to the time between pulses applied in one frame when in the full-power operating condition, and

wherein a sleep time between scans of the touch-sensitive display is greater when in the reduced power condition compared to the time between scans of the touch-sensitive display when in the full-power operating condition.

12. The non-transitory computer-readable storage medium according to claim **11**, wherein applying the first plurality of pulses comprises applying pulses to a first drive electrode during a first scan, and wherein applying a second plurality of pulses comprises applying fewer pulses to the first drive electrode during a second scan.

13. The non-transitory computer-readable storage medium according to claim **11**, wherein receiving an indication comprises receiving, from a processor, a command to enter the reduced power condition.

14. The non-transitory computer-readable storage medium according to claim **11**, wherein scanning is performed at a first scanning rate when in the full-power operating condition, scanning is performed at a second scanning rate when in the reduced power operating condition, scanning is performed at a third scanning rate in response to detecting a touch on the touch-sensitive display when in the reduced power operating condition, and wherein the third scanning rate is between the first scanning rate and the second scanning rate.

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